This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

552.47
M374

W. F. Marsters

Preliminary report of the serpentine belt of Lamoille and Orange counties, Vermont.

Montpelier, Vt., 1904.

552.47 M374

The Branner Geological Library

LELAND·STANFORD·JVNIOR·VNIVERSITY

ct

JC Branner

PRELIMINARY REPORT

OF THE

SERPENTINE BELT

OF

LAMOILLE AND ORANGE COUNTIES,

VERMONT.

W. F. MARSTERS,

Geological Laboratory, Columbia University.

MONTPELIER, VT.:
ARGUS AND PATRIOT PRINTING HOUSE.
1904.

PRELIMINARY REPORT

OF THE

SERPENTINE BELT

OF

LAMOILLE AND ORANGE COUNTIES,

VERMONT.

W. F. MARSTERS,
Geological Laboratory, Columbia University.

STANFORD LIBRARY

MONTPELIER, VT.:
ARGUS AND PATRIOT PRINTING HOUSE.
1904.

352.47
N514

214793

STANFORD LIBRARY

A Preliminary Report on a Portion of the Serpentine Belt of Lamoille and Orleans Counties.

By W. F. Marsters.

1. Pioneer work in Vermont.
2. Area considered in this report.
3. Topography.
4. Discovery of asbestos.
5. Structure and rock types.
    Amphibolite.
    Serpentine.
    Schists.
6. Origin of serpentine.
7. Asbestos, varieties and composition.
8. Production.

The occurrence of serpentine and associated minerals was early known to the pioneer geologists of Vermont. In the report prepared by Professor Edward Hitchcock and his coworkers, 1861, frequent mention is made of them and it is stated that in many instances more or less asbestos and talc in various varietal forms also appears. While considerable preliminary prospecting was carried on in the early seventies, no industry of any moment was established until a comparatively recent date.

According to the observations of Prof. Hitchcock, the serpentines are very largely confined to a broad band of talcose schists which enters the State on the north in Orleans County. The belt has a maximum width of some 15 miles and its eastern limit rests upon the western shore of Lake Memphremagog. This series of metamorphics is shown on his map as extending the entire length of the State and occupying portions of Orleans, Lamoille, Washington, Addison, Orange, Windsor and Windham counties and having a minimum width at the Southern boundary of the State of some two and a half miles. While some ten occurrences of serpentine are reported to exist in the southern half of this talcose belt, by far the largest of these deposits is located in Orleans and Lamoille Counties. What may be the areal extent of the talcose schists and included serpentines beyond the Vermont border, has not yet been determined in detail by the Canadian Geological Survey.

AREA.

The small area under consideration in this report lies within the adjoining townships ot Eden in Lamoille and

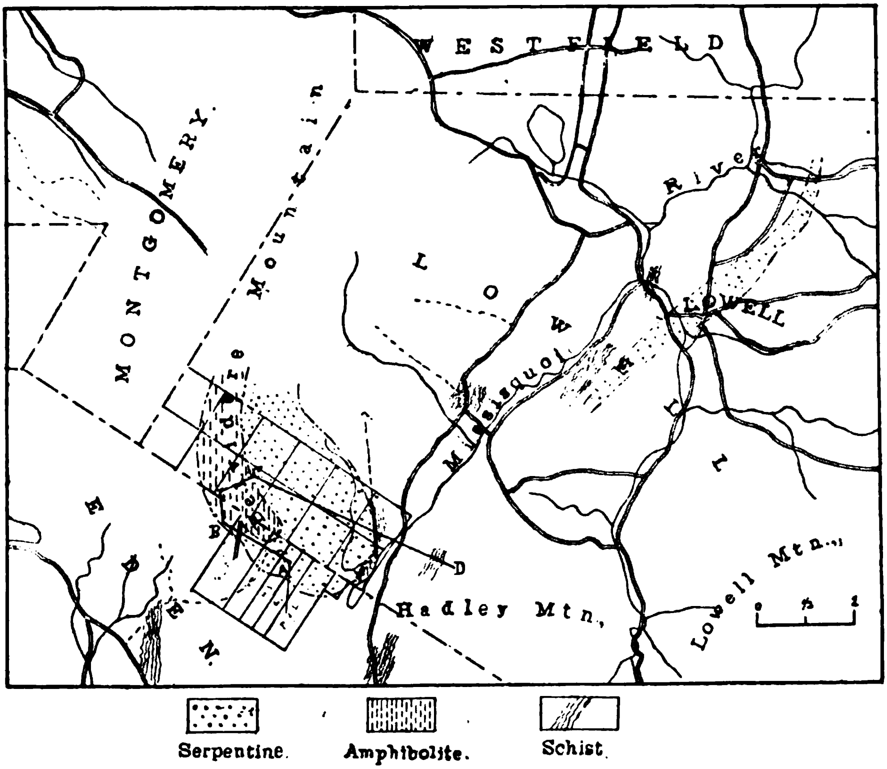

FIG. III. Map of Eden, Lowell, etc., showing Serpentine Area.
Drawn by W. F. MARSTERS.

Lowell in Orleans Counties. According to the Hitchcock map, the serpentine bands, of which there are two reported, terminate near the central part of Lowell township; the west one, however, is represented as extending a little south of the village of Lowell. In Eden township no serpentine is shown. There is, however, in Eden and continuing in Lowell, a most interesting area of these magnesian rocks forming the south slope of Belvidere Mountain, and a plateau-like projection to the southeast of its crest. This may be called the Belvidere area. Detailed study of the limits of this area force the conclusion that it is not connected with the belt passing through Lowell village.

Apart from the purely scientific interest in the origin and development of the serpentines they are, also, of special economic importance, inasmuch as considerable quantities of asbestos are known to occur within the limits of the region under consideration. Small lenses of talc, too, are not uncommon within the central part of the Belvidere area and also in the Lowell belt, but asbestos is by far the more abundant of the two and of greater economic importance. It should be added, however, that it does not follow that talc is always secondary in importance, in serpentine rocks; on the contrary, in the region of Moretown, Washington County, large talc deposits are being opened, and a mining plant is in process of construction. In this case, so far as can be determined from the preliminary prospecting, asbestos-like minerals are quite secondary to the development of talc. The talc appears to occur near the contact of serpentine with talcose and mica schists, or as small lenses within the serpentine. It is not at all improbable that careful prospecting within the limits of the Moretown area may bring to light a number of talc deposits of sufficient economic importance to form the basis of small but profitable enterprises.

TOPOGRAPHY.

Topographically, this region consists of a series of valleys and ridges having in general a north-east south-west trend. Near the western corner of Lowell lies Belvidere Mountain, a sharp-crested ridge with its highest point at its southern extremity and within a few rods of the Lowell-Eden township line. The Southern side of Belvidere Mountain is shown in Plate XXXVI. The altitude of the crest gradually decreases to the north and north-east. A steep-sloped valley locally known as Hazen's Notch in the south-west corner of Westfield separates Belvidere from the ridge on the north. Hadley Mountain is separated from Belvidere by the west branch of the Missisquoi River. From its northern flank a low spur extends to and beyond Lowell village where it is crossed by Johnson's branch, a tributary to the Missisquoi. A part of this spur is locally known as the Leland Hills. In the south-west corner of Lowell, are the so called Lowell Mountains with the same general trend as Belvidere.

The greatest altitude of Belvidere is approximately 2100 feet above Eden Corners, and some 1200 feet above the office of the New England Mining Company. The upper half of the ridge presents exceedingly steep cliffs occasionally alternating with talus slopes and "slides" containing enormous blocks of rock, the *form* of these masses being due to the development of two well-defined systems of joints. To the north, however the steepness of the slopes gradually decreases and a cover of waste extends well up the flanks. At the south end of Belvidere, a somewhat crescent shaped plateau rims the south and south-east sides. This topographic element is largely composed of serpentine rock, the level portion being comparatively free from drift or talus except along its upper edge, and again at its foot where it is in part covered up by sand or gravel deposits forming terraces on the bottom and along the lower part of the Missisquoi valley. The gradual extension of the glacial deposits up the slopes to the north and their coalition with debris from above, the whole being covered with a dense forest, renders the lithological relationships of the area between the plateau and Hazen's Notch very difficult to ascertain.

DISCOVERY OF ASBESTOS.

In the Belvidere and Lowell belts, asbestos was first discovered by Judge M. E. Tucker, November 9th, 1899. A considerable area lying along the township line as well as a portion of the belt passing through Lowell Village and to the north some two and a half miles, was prospected with considerable care.

In the vicinity of the Village and to the south much prospecting has also been done but at a later date, by Mr. Silsbey. During the two succeeding years the Belvidere area attracted the attention of some of the prominent miners of asbestos in the United States and Canada. In 1900 Mr. B. B. Blake likewise discovered asbestos in ledges on the southeast slope of Belvidere, in Eden township. These discoveries finally led to the formation of a number of companies, but only one proceeded beyond the prospecting stage. In 1901 the New England Company erected a very elaborate plant equipped with the most modern machinery necessary for the treatment of asbestos rock. Active mining operations were begun in May, 1902, but in October of the same year, the plant closed its doors. No official statement has been obtained concerning the amount or the character of the fiber produced, or its adjudged value in the market of the country. The fiber, seen by the writer, which was said to have been the product of the New England Company, while too short for purposes requiring tensile strength, should fill all standard requirements in the manufacture of all classes of asbestos goods, in which non-conductivity of heat is the only essential quality desired.

STRUCTURE AND ROCK TYPES.

Within the limits of the accompanying map, three well defined rock types were found; namely, *amphibolite*, in places assuming the appearance of a hornblendic gneiss; *serpentine*, massive, much crushed and sheared, the sheared belts being impregnated with fibrous and asbestiform minerals; talc, and lastly a large series of *talcose* and *micaceous schists.*

AMPHIBOLITE.

So far as has yet been learned, the amphibolites are confined to the crest of Belvidere Mountain. Their relation to the serpentine is shown in the accompanying cross section. They consist very largely of green hornblende; a smaller amount of a rod-like, colorless mineral, with optical properties similar to those of anthophyllite, an orthorhombic amphibole and a few garnets now largely altered and accompanied by rims of secondary origin. Magnetite is common. Quartz and feldspar grains are comparatively rare. While there is considerable variation in the texture and relative amounts of the green and colorless amphiboles the persistence of the members of the amphibole family and the general absence of both quartz and feldspar, except as secondary products, make the rock a fairly typical amphibolite. No attempt will be made in this paper to discuss, in detail, the microscopical characteristics and probable origin of this rock. The problem is a difficult one and will be reserved for later consideration and publication in a subsequent report of the State survey.

SERPENTINE.

No sharp and well defined contact between the serpentine and the overlying amphibolite has been discovered. Such may not exist. Examination of thin sections points to the conclusion that a sharp line of contact does not occur here, but, on the contrary, the amphibolite has gradually altered to serpentine. The thin sections of the serpentine within a few feet of undoubted amphibolite show shreds and remnants of an amphibolite surrounded by a felty mass of serpentine, often colorless, or very faint greenish yellow. It would thus seem very probable that the serpentine is a secondary product resulting from the decomposition of the amphibolite. The zone between typical amphibolite and undoubted serpentine is characterized by an abundance of garnet easily recognized by the unaided eye, but under the microscope it appears to have suffered considerable alteration with the development of rims of secondary origin. In a few cases the entire mass of the garnet has altered to a light green isotropic mass, probably serpentine.

The serpentine occurs in two areas, designated as the Belvidere and the Lowell. The Belvidere area constitutes the plateau-like projection at the south end of the range. Its areal extent, so far as known, is shown on the accompanying map. It is possible that a connection between it and the Lowell belt may exist beneath the tile covering the floor and the lower flanks of the Missisquoi valley. There are, however, certain structural phenomena which do not favor such a view. Near the foot of the plateau, at the asbestos opening made by Judge M. E. Tucker is a well defined fault with north and south strike and vertical dip; to the east of the fault-line, amphibolite, of the same general character as that forming the crest of Belvidere, forms the only rock in sight. Neither the area of the amphibolite nor the extent of the fault could be traced more than a few score of feet from the Tucker quarry. These structural facts would lend credence to the conclusion that the Belvidere occurrence is not continuous with that of Lowell. On the west side of the serpentine, a local fault occurs on the property of the National Company. It was first noted by Prof. J. F. Kemp, Columbia University, whose account of the serpentine and asbestos appears in the Mineral Industries, for 1900. The extent of the fault cannot be determined. It is not improbable that it may turn towards the west and skirt the west flank of Belvidere Mountain. Again, on the southern slope and to the southeast of the Tucker opening, there is a repetition of the same lithological changes recognized at the upper edge of the plateau. Thin sections show a considerable amount of fresh amphibole, but the series of abrupt ridges extending from the Tucker opening are very largely composed of fine grained felty serpentine. The facts, therefore, so far observed go to support the conclusion that the Belvidere is not a continuation of the Lowell belt. The accompanying Cross Section, Fig. IV, makes clear the conclusions here presented.

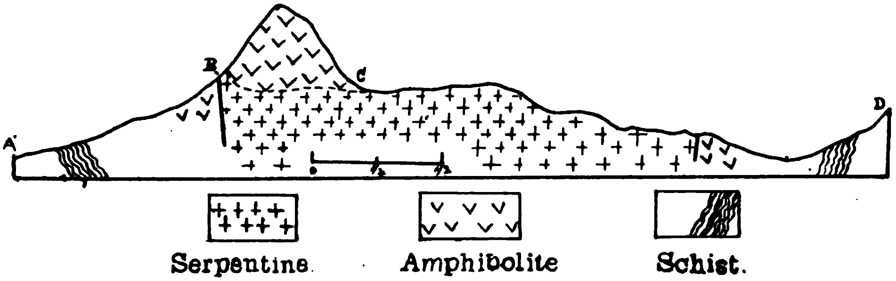

FIG. IV. Section through Belvidere Mountain.

The limits of the Lowell belt have only been approximately determined. An excellent section can be seen at the Village of Lowell, where considerable prospecting for asbestos has been done by Mr. Silsbey. No actual contacts of the serpentine with schists or amphibolite were found in this section. To the north some two or two and a half miles, the serpentine deposits form a narrow ridge overlooking the valley of the Missisquoi River on the west. Beyond the Perkins farm no serpentine was discovered. It is not improbable that it is pinched out at this point and recurs to the north as lenses at the various points reported by Hitchcock. To the south of Lowell, these magnesian rocks can be traced and have been prospected for a mile or more. Whether the deposit pinches out or continues into the slope of the spur of Hadley Mountain is not known.

Macroscopically the serpentine of the two belts is identical. It is an exceedingly tough, rather fine grained rock and light to dark green in color, but sometimes assuming a gray tint; in such cases the rock is generally minutely scaly in structure, and associated with talc-like bands of limited extent. In the Belvidere belt in particular the serpentines have been sheared and crushed to such an extent that minutely fractured bands may be traced for some distances. These are best shown at the Tucker openings along the lower limit of the belt and in the series of prospect holes extending from the Northwest corner of the National claim to and including those on the New England and the United States properties. The Fracturing and asbestos-like filling of the ruptures may be even microscopic in size. It is apparently along these lines of fracture that the fiber has developed. While it was exceedingly difficult to study in great detail the structure of the central portion of the Belvidere belt, such data as was obtained shows that the maximum amount of crushing and fracturing was produced near the upper and lower limits, and along lines of faulting. It is in these zones of greatest disturbance that the greatest amount of fiber is developed.

As seen under the microscope the serpentine presents a considerable range of variations both structurally and mineralogically. In its most typical phase it is a colorless or slightly yellow or yellowish green mass of grains, scales and fibrous bundles. The fibrous texture is scarcely apparent except in polarized light. The more massive phase is often nearly isotropic, while the fibrous presents a felty texture. When individual fibres could be examined they were found to behave in a manner similar to anthophyllite. In many sections there was an abundance of magnetite. A portion of this may be chromite and picotite. The arrangement of the ores is suggestive of the structure of the rock from which the serpentine was derived. Numerous illustrations could be sketched of the linear arrangement of the magnetite grains in parallel lines as if developed along cleavage partings. The green amphibole seen in the fresh amphibolite presents in certain sections an exact duplicate of the cleavage; in fact, it is believed that a more detailed study of sections, now in course of preparation, will show various stages of decomposition and final passage into massive and fibrous phases of serpentine, with the magnetite as a secondary product.

It should be stated that such a mode of origin has already been recognized by Professor B. K. Emerson* in his investigations of " The Geology of Old Hampshire County, Mass." In a belt extending from Zoar to North Blandford, he has recognized, in addition to the association and undoubted derivation of serpentine from hornblendic schists (amphibolite), similar relationships of serpentine with olivine, enstatite and sahlite. With these mixtures are associated large beds of crystalline limestone, dolomite and tremolitic schists. Concerning the whole series, Prof. Emerson says "The presence of dolomite as an original constituent, both as inclusions in the unchanged enstatite and in the interstices of the enstatite rock, as well as in great beds, indicates the derivation of the whole series from large beds of dolomitic limestones."

The asbestos occurs in two distinct forms, usually designated as " slip fiber " and " vein fiber." Such examination as has been made of the slip fiber shows it to be a fibrous form of amphibole; the vein fiber, on the other hand, is probably true chrysotile. Both kinds are found in the Belvidere as well as the Lowell belt, and are best developed either in the immediate vicinity of the faults or near the upper and lower contacts of the serpentine with the amphibolites. A very good showing of the vein fiber was discovered near the northeast line of the New England property, some on the United States, but by far the best showing can be easily seen on the Tucker properties along the lower contact. Both slip and vein fiber occur at the Perkins farm and again in the ledges within the limits of Lowell village on property owned by Mr. Silsbey. At some of these points the showing of fiber is so promising that it is confidently believed that careful prospecting and the economic management of modest plants will establish profitable enterprises in the manufacture of asbestos fiber of second and third grades. Fiber fulfilling the demands of fair grades of paper stock, asbestos board, etc., has already been made from the ore from the Tucker, National and United States properties. No statistics, however, of the production per ton of ore, have been obtained.

---

*Geology of Old Hampshire County, Mass., Mon. XXIV. U. S. G. S, pp. 115, 116.

SCHISTS.—The talcose and mica schists are well exposed on the south and southwest of Belvidere. Towards the east and along the slopes of the Missisquoi Valley, in the vicinity of Lowell, very excellent exposures may be seen. The entire series, so far as seen, maintains a general northeast-southwest strike and nearly vertical dip, although to the southwest of Belvidere it swerves towards the north.

While this most puzzling formation presents structural features and to some extent a mineral constitution, which would suggest a sedimentary origin, a detailed microscopic study of the entire terrane may reveal a mass of data which would necessitate a change of view based upon macroscopic characters.

ORIGIN OF SERPENTINE.—Serpentine was early recognized as occuring in large masses as rock, and also in crystalline form as a mineral. As early as 1835 Quenstedt* discovered crystals of

---

*Poggendorf's Annalen fur Physik und Chemie, Vol. XXXVI, p. 370.

serpentine, in the region of Snarum, Norway. From a careful investigation of this material he was able to demonstrate that it had been produced by the alteration of olivine. Although his conclusions met with vigorous opposition, the additional observations and studies of Rose, Volger and, later, Roth, substantiated the views of Quenstedt. In his classic memoir, J. Roth* discusses this problem in its entirety. In "British Petrography" Teall gives a condensed statement of the views of Roth. He says; "In this memoir, the author points out that the ordinary agents of weathering-water, carbonic acid and oxygen—are powerless to remove alumina; and he draws the general conclusion that if a non-aluminous silicate rock occurs as an alteration product, it must arise from the modification of an original rock free of alumina. Powerful chemical agents such as sulphuric acid, which may arise from the oxidation of pyrites, capable of removing alumina, would of course also remove the other bases including the magnesia necessary for the formation of serpentine. Now the rock serpentine is practically non-aluminous, and it is also in most, if not in all, cases, unquestionably an alteration product. It becomes important, therefore, to consider what common rock-forming minerals are capable of yielding serpentine. The above considerations point to the conclusion that these minerals are olivine, the rhombic pyroxenes, diallage, and non-aluminous hornblende and augite. According to the author the process of making serpentine commences by the taking up of water and by the oxidation of the iron if infiltrating water contains free oxygen. It proceeds by the removal of the bases, especially lime if present, mainly as carbonates; and a portion of the precipitated and therefore soluble silica. If we take the case of olivine, then assuming
that no change of volume occurs, from 5 molecules $= 10\ MgO + 5\ SiO_2$
by removing $4\ MgO + 1\ SiO_2$
and adding $4\ H_2O$ we have $6\ MgO + 4\ SiO_2 + 4\ H_2O$
or in other words two molecules of serpentine."

In a like manner Roth has also established the derivation of serpentine by the alteration of monoclinic pyroxenes.

---

*Uber den Serpentin und die genetischen Beziehungen desselben. Abh. d. k. Akad d. Wiss. Berlin, 1869.

The well known close association of some serpentines with dolomitic rocks and ophicalcites has given some ground for the belief that these magnesian rocks may have been produced by the alteration of a mass high in magnesian carbonate. This process, however, is not regarded with favor, either by Roth or Teall, who are inclined to accept the view that such serpentine masses as may be associated with crystalline limestones and dolomitic rocks, may have been derived from malacolite, tremolite, etc., which develop in these rock masses by processes of metamorphism.

Some observers have also maintained that serpentine has been produced by the alteration of members of the feldspar family. Supposed cases of this sort have been described by Heddle,* and Bischof† has worked a series of chemical reactions purporting to explain the succession of chemical changes. Careful examination has shown, however, that the final alteration product investigated by Heddle was not true serpentine, but pennine (pseudophite).

ASBESTOS. VARIETIES AND COMPOSITION. — Considered from the standpoint of the mineralogist, the term asbestos appears to be a general one, which has no well defined generic or specific value. As used by Dana, the term is made to include fibrous forms of four distinct mineral compounds. In a careful study of the asbestos series in the geological department of the National Museum, Dr. C. P. Merrill discovered that the commercial asbestos included fibrous forms of (1) monoclinic amphibole (tremolite), (2) serpentine (amianthus), (3) anthophyllite, and (4) crocidolite (blue asbestos). Concerning these species Dr. Merrill says: "Of these, tremolite and serpentine have long been recognized in fibrous forms, and are as a rule readily distinguishable from one another by the silky fiber and greater flexibility of the last named.

"Asbestiform crocidolite is well known to most mineralogists, though so far as the present writer is aware, the South African locality is the only source of the mineral in commercial quantities. That the fibrous form of anthophyllite is also sufficiently common to be commercially used as asbestos, seems not to be so well understood, though the leading text-books on the subject all mention the mineral as sometimes occurring in fibrous forms resembling asbestos. That a lack of discrimination between fibrous anthophyllite and the true tremolite asbestos should exist is not strange, since to the unaided eye they are often in every way alike, and it is only by microscopic or chemical means that the true nature of the mineral can be made out." The best grade of asbestos, Italian and Canadian, *very* finely fibrous with *silky lustre* and usually occurring in veins with the fiber normal to the vein-walls, is a fibrous form of *serpentine*, and properly called chrysotile, both by the mineralogist and the tradesman. Under this term Dana includes much of the silky amianthus associated with serpentine rocks and popularly regarded as asbestos. The term *Bostonite*, too, has been applied by the trade to the Canadian chrysotile. The second and third grades may be regarded as fibrous forms of the non-aluminus members of the amphibole family. Considered as a group, the color is light to deep green or bluish green; the fiber may be fine and wooly in texture and easily separated, but it differs from the chrysotile, in that it is often harsh, flexible to a limited degree and waxy or dull in luster. These grades lack any marked degree of tensile strength and hence are not suitable for the manufacture of articles requiring a high degree of flexibility and strength, such as cloth, rope, etc., but is all that can be desired for uses wherein non-conductivity of heat is the only essential quality desired.

---

*Heddle, Trans. Royal Soc. Edin. 1879. Vol. XXVIII p. 544.

†Bischof Chemical and Physical Geology, Eng. Edit., Vol. II., pp. 66 and 67.

Asbestos is essentially a hydrated silicate of magnesia, with a small but variable amount of the oxides of iron and alumina present. Analyses of Italian and Canadian Chrysotile made under the direction of Mr. J. T. Donald yielded the following results:

CHRYSOTILE.

	I.	II.	III.
(1) SiO_2	40.30	40.57	40.52
(4) MgO	43.37	41.50	42.05
(3) FeO	.87	2.81	1.97
(2) Al_2O_3	2.27	.90	2.10
(5) H_2O	13.72	13.55	13.46

I. Italian as found in commerce. II. Canadian, best grade, Thetford-Black Lake district. III. Templeton, Ottawa district.

A comparison of these analyses with those of the amphibole variety appended below, reveals certain differences of much value to the prospector.

ASBESTOS, AMPHIBOLE VARIETIES.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
(1) SiO_2 ...	55.87	55.48	57.69	57.12	57.73	59.00	52.11	53.28
(2) Al_2O_3 ..	.....	2.01	.....	0.75	.72	.91	1.01	.....
(3) Fe_2O_3 ..	.....	.....	.....	.....	.....	.....	20.62	.....
(4) FeO ...	4.31	.....	2.46	6.36	8.61	6.09	16.75	.....
(7) MnO ..	1.12	.....	0.13	.....	.....	.....	.....	.....
(6) MgO...	20.33	17.23	23.68	29.44	28.77	29.90	1.75	22.87
(5) CaO....	17.76	10.35	13.39	.....	0.08	.45	none.	.....
(10) Ign....	.....	1.47	0.17	5.74	2.52	2.35	1.58	19.53
(9) Na_2O ..	.....	1.54	3.14	.....	0.57	.68	6.16	.....
(8) K_2O ...	.....	.....	.....	.....	0.14	.43	....	.....

I. From Zillerthal. II. From Mexico. III. From Frankenstein.

IV. Anthophyllite. Sall Mountain, Ga., R. L. Packard.
V. do. Nacoochee Ga., R. L. Packard.
VI. do. Mitchell Co., N. C., anal. by R. L. Packard.
VII. Crocidolite, South Africa, Dana, p. 400.

VIII. Crocidolite, Idaho, G. P. Merrill: Notes on asbestos and asbestiform minerals. Proc. U. S. Nat'l Mus. Vol. XVIII, pp. 281-292.

It will be seen that the latter contains from 15 to 17 per cent. more SiO_2 but only half the amount of MgO. This deficiency is apparently made up by the substitution of 10 to 17 per cent. CaO. The two groups may be therefore easily determined by proving the presence or absence of calcium and water. The chrysotile yields an abundance of water but fuses with great difficulty on the edges of the fiber. $F = 6$. The amphibole and pyroxene varieties, however, fuse easily and yield little or no water in the closed tube.

(8) PRODUCTION.—An inspection of the tabulated data dealing with the production of asbestos in the United States, during the past ten years, reveals the unexpected fact that the annual output was considerably less than 1,000 short tons, this mark being exceeded in 1900 by an additional 54 tons, and again in 1902, by 5 tons. In 1882, the output reached some 1,200 tons with an estimated value of $36,000. In 1901 the total production fell to 747 tons, with an estimated value of $13,498, but in the following year again increased nearly 50 per cent. and was valued at $16,200. A comparison of values and amount of production shows that the increase in output has been accompanied by a corresponding fall in prices. During the past two years, however, the growing demand for all grades of the crude product, has increased the values, especially of the better grades, where strength of fibre is an essential quality.

While asbestos is known to occur in many localities in the United States, the most productive field during 1902 was the Sall Mountain, White County, Ga. It is operated by the "Sall Mountain Asbestos Co."

ANNUAL PRODUCTION OF ASBESTOS IN THE UNITED STATES,

1890-1902.

YEAR		QUANTITY SHORT TONS	VALUE
1890	....	71	$ 4,560
1891	....	66	3,960
1892	....	104	6,416
1893	....	50	2,500
1894	....	325	4,463
1895	....	795	13,525
1896	....	504	6,100
1897	....	580	6,450
1898	....	605	10,300
1899	....	681	11,740
1900	....	1,054	16,310
1901	....	747	13,498
1902	....	1,005	16,200

VALUE OF IMPORTED ASBESTOS 1890-1902.

YEAR ENDING	UNMANUFACTURED.	MANUFACTURED	TOTAL
1890	$ 252,557	$ 5,342	$257,899
1891	353,589	4,892	358,461
1892	262,433	7,209	269,642
1893	175,602	9,403	185,005
1894	240,029	15,989	256,018
1895	225,147	19,731	244,878
1896	229,084	5,773	234,857
1897	263,640	4,624	268,264
1898	287,636	12,897	300,533
1899	303,119	8,949	312,068
1900	331,796	24,155	355,951
1901	667,087	24,741	691,828
1902	729,421	33,011	762,432

ANNUAL PRODUCTION OF ASBESTOS IN CANADA,

1890-1902.

YEAR	QUANTITY SHORT TONS	VALUE
1890	9,860	$ 1,260,240
1891	9,279	999,978
1892	6,042	388,472
1893	6,473	313,806
1894	7,630	420,825
1895	8,756	368,175
1896	12,250	429,856
1897	a30,442	445,368
1898	a23,785	486,227
1899	a25,536	485,849
1900	a30,641	763,431
1901	a38,079	1,186,434
1902	b40,416	1,148,319

a Including asbestic. b Including 10,197 tons of asbestic.

PRODUCTION OF ASBESTOS IN THE WORLD IN METRIC TONS*.

Year	Canada.		Cape Colony(c)		Italy		Russia		United States	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
1898	21,577	$ 486,227	161	$ 10,185	131	$ 9,000	1666	$ 60,000	803	$ 13.425
1899	22,938	483,299	[b]	....	81	7,264	2693	97,342	827	13,860
1900	27,797	748,431	157	12,785	[b]	....	[d]	....	998	16,500
1901	36,475	1,259,759	89	7,165	[b]	....	[d]	....	678	13,498
1902	36,668	1,203,452	[d]	....	[d]	....	[d]	....	916	12,400

[a] From official reports of the respective countries.
[b] Not stated in the reports.
[c] Exports.
[d] Statistics not yet available.
[*] The Mineral Industries, its Statistics Technology and Treas. for 1902, Vol. XI.

Statistics show, also, that the value of the total imports, manufactured and unmanufactured, for the year 1902, is $762,432. Nine-tenths of this is obtained from the Canadian mines. According to the statistics gathered by Henry Fischer on the world production of asbestos, Canada produced during the calendar year, 1902, 36,668 metric tons valued at $1,203,452. It follows from these facts that the United States have imported more than half the value of total production of Canada. Under these conditions it is evident that the demand for this product ought to foster careful and detailed investigations of all the most promising areas within our own borders. Vermont should receive her share of attention and careful study. There is surely sufficient evidence of the existence of fibre in large quantities within the Belvidere and Lowell areas to warrant much additional careful and prudent prospecting and detailed study.

GAYLORD BROS.
MAKERS
SYRACUSE, - N.Y.
PAT. JAN. 21, 1908

T av fine, this bo
ore the dat

552.47 .M374 C.1
Preliminary report of the serp
Stanford University Libraries
3 6105 032 147 329